Meeting Minutes of August 20, 2019
Extreme Storm Events Work Group (ESEWG) of the Federal Subcommittee on Hydrology (SOH)

On Tuesday, August 20, 2019, @ 2:30 p.m. EDST, the National Weather Service (NWS) hosted a meeting of the Extreme Storm Events Work Group (ESEWG) in their Silver Spring, Maryland, offices. The hosts were Dr. Sanja Perica, Chief, Hydrometeorological Design Studies Center (HDSC), Office of Water Prediction (OWP), NWS, National Oceanic and Atmospheric Administration (NOAA) and Michael St. Laurent, University Corporation for Atmospheric Research (UCAR), Cooperative Programs for the Advancement of Earth System Science (CPAESS), HDSC. The meeting, which was organized and chaired by Thomas Nicholson, U.S. Nuclear Regulatory Commission (U.S. NRC), followed the attached meeting agenda sent out a month prior to the meeting. The meeting's theme was ***Quality Assurance (QA)/Quality Control (QC) of precipitation gauge datasets and gridded precipitation products***.

Of special note, attending the meeting in person and participating were:

- Mark Glaudemans, Director, Geo-Intelligence Division, OWP, NWS, NOAA
- Michael St. Laurent, UCAR, HDSC, NWS, NOAA
- Carl Trypaluk, UCAR, HDSC, NWS, NOAA
- Dale Unruh, HDSC, NWS, NOAA
- Victor Hom, NWS, NOAA
- Marian Baker, NWS–Kansas City. NOAA
- Michelle (Shelby) Bensi, Department of Civil and Environmental Engineering, University of Maryland

Of special note, attending via *Google Meet* and participating were:

- William Asquith, Texas Tech and USGS – Lubbock, TX
- Meredith Carr, Hydrologist, USNRC, RES
- Boris Faybishenko, Lawrence Berkeley National Laboratory
- Jason Giovannettone, Dewberry Co.
- Scott DeNeale, ORNL
- Barbara Hayes, U.S. NRC/NRO
- Shih-Chieh Kao, ORNL
- Bill Kappel, Applied Weather Associates
- Kristen McSwain, USGS and ACWI Federal Coordinator
- Brian Nelson, National Center for Environmental Information (NCEI), Asheville, NC
- Kevin Quinlan, U.S. NRC/NRO
- Sanja Perica, HDSC, NWS, NOAA
- Mark Perry, Dam Safety Branch, Division of Water Resources, Colorado Department of Natural Resources
- Rajiv Prasad, Pacific Northwest National Laboratory
- Ramesh S. V. Teegavarapu, Florida Atlantic University
- Will Thomas, Michael Baker Associates and Chair, Hydrologic Frequency Analysis Work Group, SOH
- Katie Ward, MetStat Inc.

Thomas Nicholson, ESEWG Chair, opened the meeting by introducing the attendees and thanking the meeting coordinator, Michael St. Laurent, NOAA, NWS Contractor, and Mark Glaudemans, Director, Geo-Intelligence Division, OWP, NWS, NOAA, for hosting the meeting. Tom reviewed the meeting agenda.

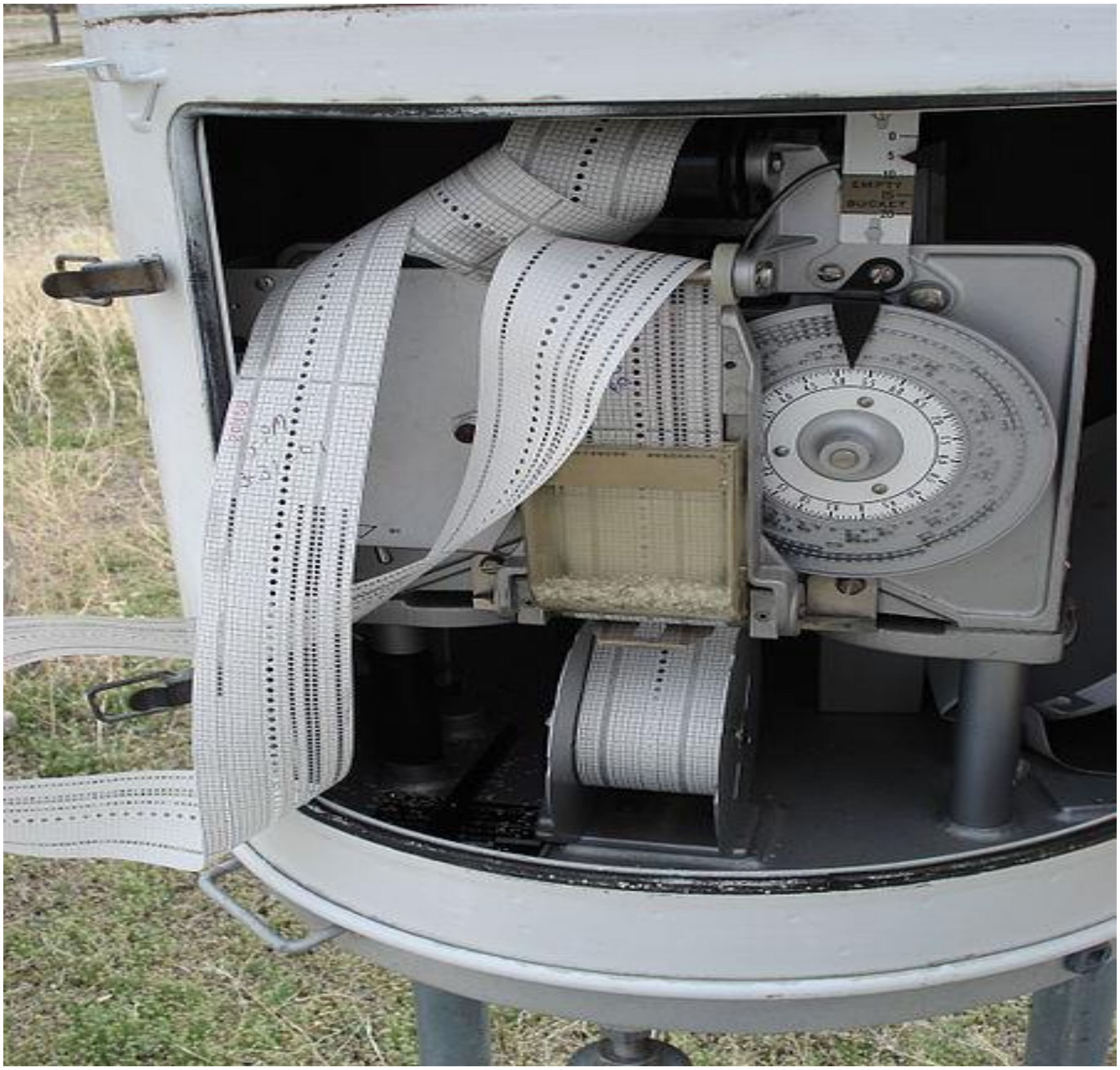
Tom introduced ***Victor Hom, the NWS/NOAA representative to the Subcommittee on Hydrology (SOH) and former Chair of SOH.*** Victor discussed an important announcement made at the July 18, 2019, SOH meeting involving the Advisory Committee on Water Information (ACWI) and its subcommittees and workgroups. Victor mentioned that Kristen McSwain, USGS, is the designated Federal officer for ACWI. At the SOH meeting, Kristin announced that ACWI is being reformulated. All its subcommittees are under review for possible termination or continuance. In her new role as the Federal officer, she needs to sit and listen to every committee, subcommittee, and workgroup meeting chartered by ACWI. Previously, no one calendar existed for all ACWI activities. Kristen announced that her supervisor at the Department of Interior wants a schedule of all ACWI activities and wants her to attend. The new policy is that chairs of the SOH and its workgroups need to e-mail Kristen with a proposed meeting agenda and time for her coordination before it is sent out to the subcommittee/workgroup members. If she can't attend, the meeting cannot be held. Kristen indicated that she has our August 20, 2019, ESEWG meeting agenda on her calendar.

Mark Glaudemans asked Victor the status of the ***Extreme Rainfall Product Needs Proposal.*** Victor mentioned that the SOH had approved the ***Proposal*** and sent it to ACWI. He reported that the ACWI is being reconstituted, and he anticipates that when ACWI reconvenes after October 1, 2019, it will discuss the ***Proposal.***

Tom next introduced ***Brian Nelson, National Centers for Environmental Information (NCEI)***, who presented a ***Brief Synopsis of Select Precipitation Data Sets and Their Level of QC***. *Brian focused on the following NCEI precipitation data sets:*

1. ***Hourly Precipitation Data (HPD)***
   ftp://ftp.ncdc.noaa.gov/pub/data/hpd/readme.txt

HPD consists of hourly precipitation totals from the NWS Fischer-Porter network of rain gauge stations throughout the United States and its territories. HPD has been in operation since the mid-20th century. It provides rain gauge depths every 15 minutes and summed into hourly totals. This information was previously provided as the National Climatic Data Center's (NCDC) DSI-3240 datasets and archived as "punch-paper" recording until 2004.



NWS Fischer-Porter rain gauge station providing "punch-paper" recording.

HPD is now stored on onsite dataloggers and downloaded to a "thumb" drive during monthly site visits.

NWS Fischer-Porter rain gauge station providing digitized recordings.

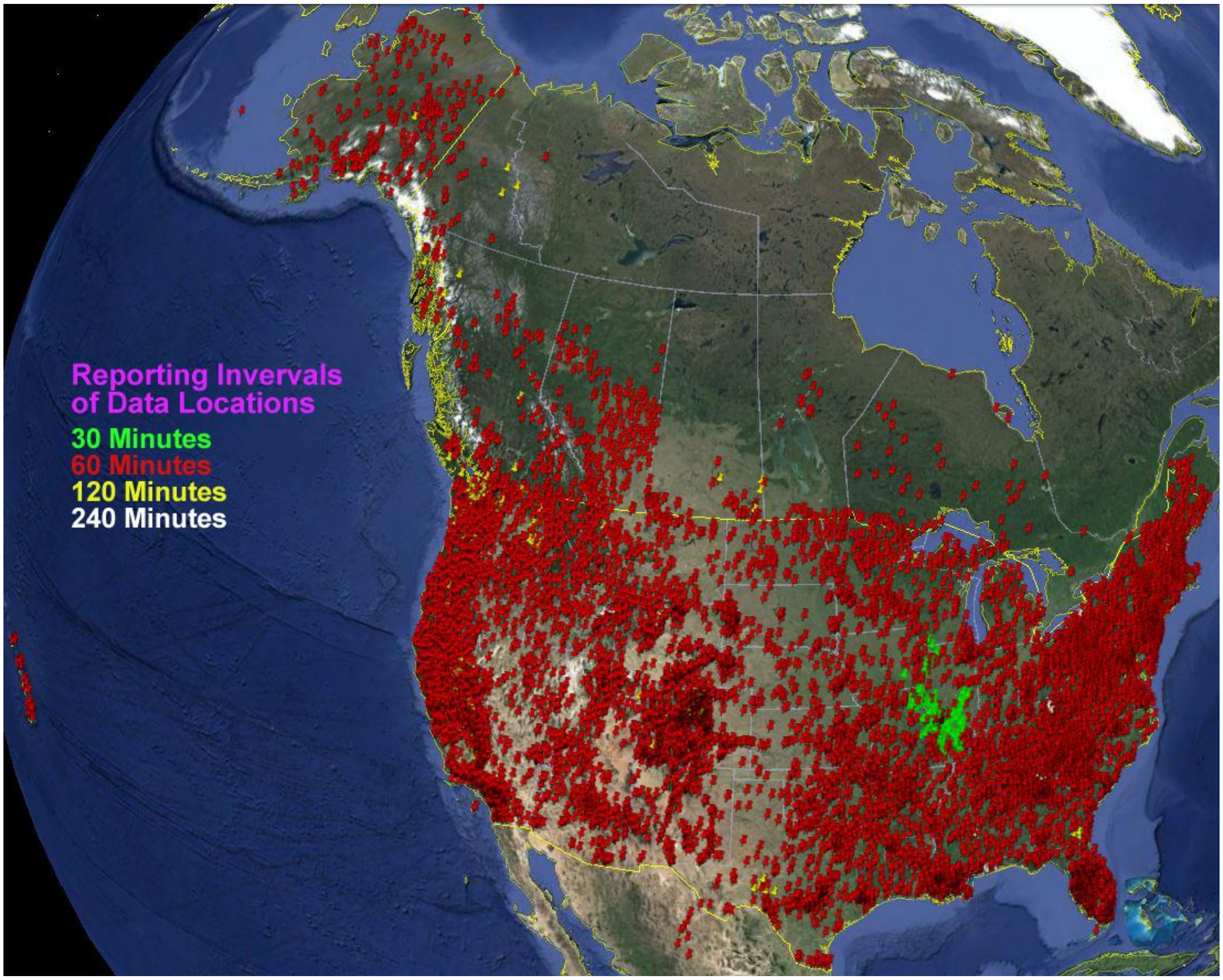
NCEI processes HPD in three main steps:

- Ingest and conduct integrity check.
- Gauge depth QC involving filtering, removing diurnal fluctuations, and checking for malfunctioning gauges, and then converting to incremental precipitation.
- Period of record hourly QC involving basic integrity and outlier checks; and data input.

HPD data is available at ftp.ncdc.noaa.gov/pub/data/hpd/auto/v1/beta/.

2. **Hydrometeorological Automated Data System (HADS)**
   https://hads.ncep.noaa.gov/

HADS involves real-time and near real-time data acquisition operated by the NWS Office of Dissemination. Raw hydrological and meteorological observation messages are sent from the GOES (Geostationary Operational Environmental Satellites) Data Collection Platforms (DCPs) and are archived at NCEI in SHEF format. HADS provides data to many Federal agencies including SOH members and others.



HADS reporting intervals for data locations in the U.S. and Canada.

3. **Global Historical Climatology Network (GHCN-daily)**
   https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/global-historical-climatology-network-ghcn

The Global Historical Climatology Network (GHCN) is an integrated database of climate summaries from land surface stations across the globe that have been subjected to a common suite of quality assurance reviews. The data are obtained from more than 20 sources. Some data are more than 175 years old, while others are less than an hour old. GHCN is the official archived dataset, and it serves as a replacement product for older NCEI-maintained datasets that are designated for daily temporal resolution (i.e., DSI 3200, DSI 3201, DSI 3202, DSI 3205, DSI 3206, DSI 3208, DSI 3210, etc.).

The first Global Daily Dataset under the Global Daily Climatology Network (GDCN) was released on CD in July 2002 based upon data obtained through personal contacts and data from Environment Canada. GDCN Version 1 includes a cooperative observer summary of the day and "First Order Summary of the Day."

The Quality Assurance (QA) of GHCN involves 19 different checks on the 5 elements – TMAX, TMIN, PRCP, SNOW, and SNWD. There is a low false-positive rate overall. The total flag rate is equal to about 0.24 percent with the highest flag rates for snowfall and snow depth. The QA checks are for basic integrity, outliers, internal and temporal consistency, and spatial consistency. Brian went through examples of these QA checks.

NCEI provides access to several online tools for use with climate research, analysis, and error-reporting. Detailed information about each of these tools can be found below.

- Datzilla
  Datzilla is a Web-based system for NOAA employees to report and track errors against NOAA datasets and data products. Non-NOAA employees can report errors to ncdc.orders@noaa.gov . Brian reviewed through Datzilla examples and how NCEI staff resolve them.

- Weather and Climate Toolkit
  The Weather and Climate Toolkit application provides simple visualization and data export of the weather and climate data archived at NCEI. The Toolkit displays custom data overlays, Web Map Services (WMS), animations, and basic filters.

- GIS-Based Map Interface (Climate Data Online)
  The GIS-Based Map Interface provides specialized dynamic mapping capabilities for datasets and products archived at NCEI. These capabilities include advanced searching, data access to various PDF and text output, accumulation maps, and historical mapping of observed and summarized data.

- NOMADS Ensemble Probability Tool
  NOAA's Operational Model Archive and Distribution System (NOMADS) Ensemble Probability Tool allows users to query the Global Ensemble Forecast System (GEFS) without downloading the data. The tool allows the user to describe a set of conditions and to determine the probability that those conditions will occur at a given location.

- Calculators and Conversion Tables
  These calculators and conversion tables help people understand and interpret weather and climate data, including converting temperature between Celsius and Fahrenheit, calculating wind chill, or estimating wind speed.

Brian discussed a recurring problem where weather stations may have many aliases and the data is reported through other systems. The **Historical Observing Metadata Repository** (HOMR) is NCEI's integrated station history database that provides ***in situ*** or land-based station **metadata** in support of NCEI research, reporting, data products, and web applications. HOMR tracks detailed information for a variety of weather stations throughout their lifespans including identifiers, names, locations, observation times, reporting methods, photos, and equipment modifications and siting. Station histories are most extensive for the NWS Cooperative Observing Program, and they include officially documented station changes that adhere to an NWS approval process. Use the search below to access these historical station details.

4. **U.S. Climate Reference Network**
   https://www.ncdc.noaa.gov/crn/

The U.S. Climate Reference Network (USCRN) is a systematic and sustained network of climate monitoring stations with sites across the conterminous United States, Alaska, and Hawaii. These stations use high-quality instruments to measure temperature, precipitation, wind speed, soil conditions, and more. Information is available on what is measured and the USCRN station instruments. The vision of the USCRN program is to provide a continuous series of climate observations for monitoring trends in the Nation's climate and supporting climate-impact research. Stations are managed and maintained by NCEI.

5. **NWS Stage IV gridded precipitation**
   https://www.emc.ncep.noaa.gov/mmb/ylin/pcpanl/stage4/

The National Centers for Environmental Predictions (NCEP) Stage IV analysis is a mosaic of Qualitative Precipitation Estimates (QPE) using the regional hourly/6-hourly multi-sensor (radar and gauges) precipitation analyses (MPEs) produced by the 12 River Forecast Centers over CONUS. Some manual QC is done at the RFCs.

Brian discussed the assessment and implications of NCEP State IV QPE for Precipitation Product Intercomparisons.

Tom next introduced **Robert Shedd, Service Coordination Hydrologist, National Weather Service's (NWS) Middle Atlantic River Forecast Center (MARFC)** who provided ***An Example of a River Forecast Center's Precipitation Processing Procedures. Marian Baker, NWS Central Region.*** Marian Baker, NWS–Kansas City was a co-author on the presentation and provided additional details.

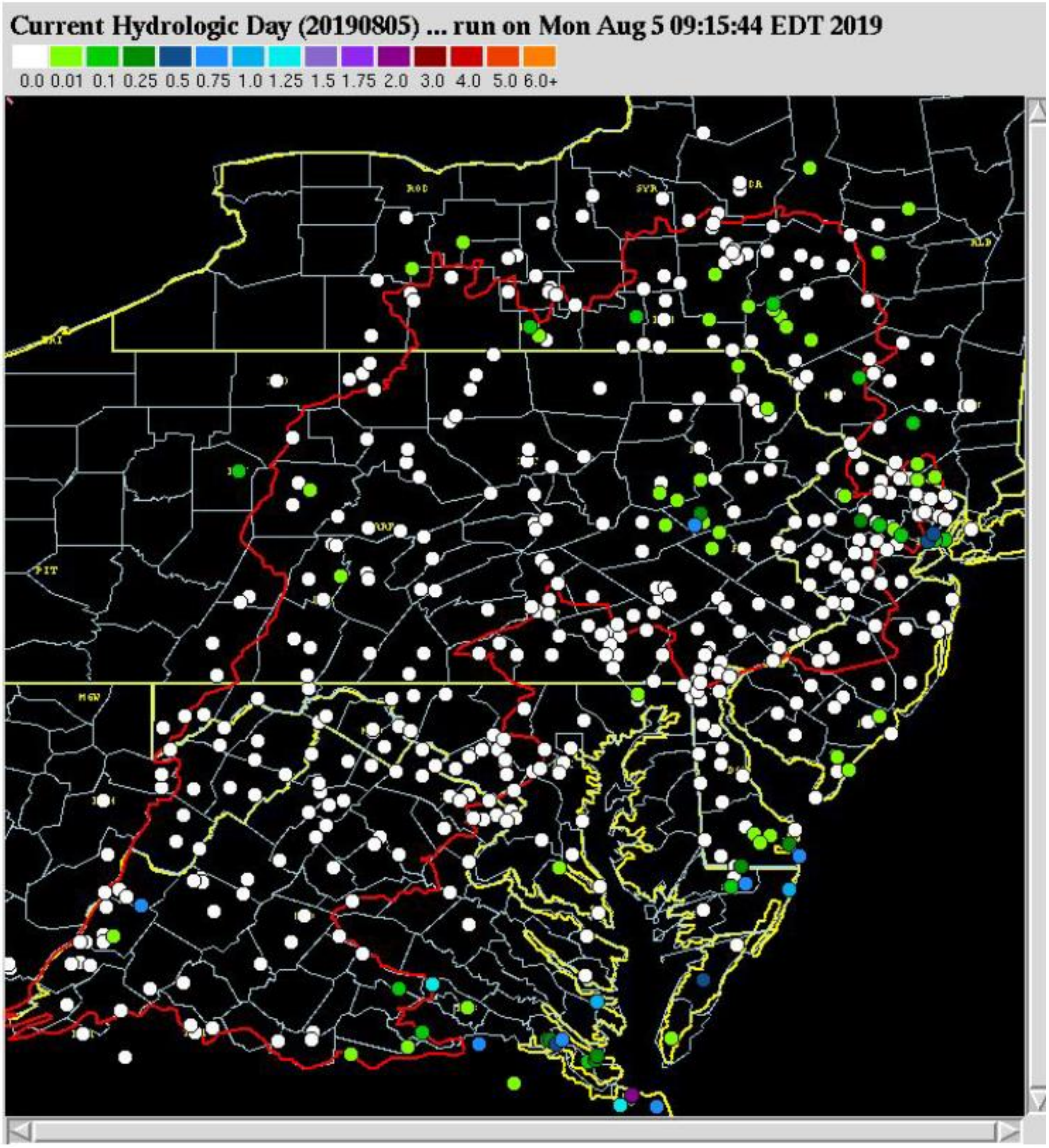
Rob began by describing observed precipitation processing at the Middle Atlantic River Forecast Center (MARFC). The data involve both multi-sensor precipitation (MPE) and gage-based precipitation. The MPE consists of radar-gage combinations, data processed on hourly timesteps, re-processed data following morning collection, and NWS daily accumulations available at https://water.weather.gov. The gage-based precipitation consists of hourly data processed in MPE application, 6-hour data processing, and daily precipitation procedures. Both the MPE and gage-based precipitation datasets are sent to the RFC forecast system, but the MPE dataset is the default.

For the MPE data processing, several different precipitation fields are available:

- Legacy multi-sensor, radar-only, gage only with different bias procedures.
- Dual Polarization data sets.
- MRMS (multi-radar, multi-sensor) data from the NCEP.

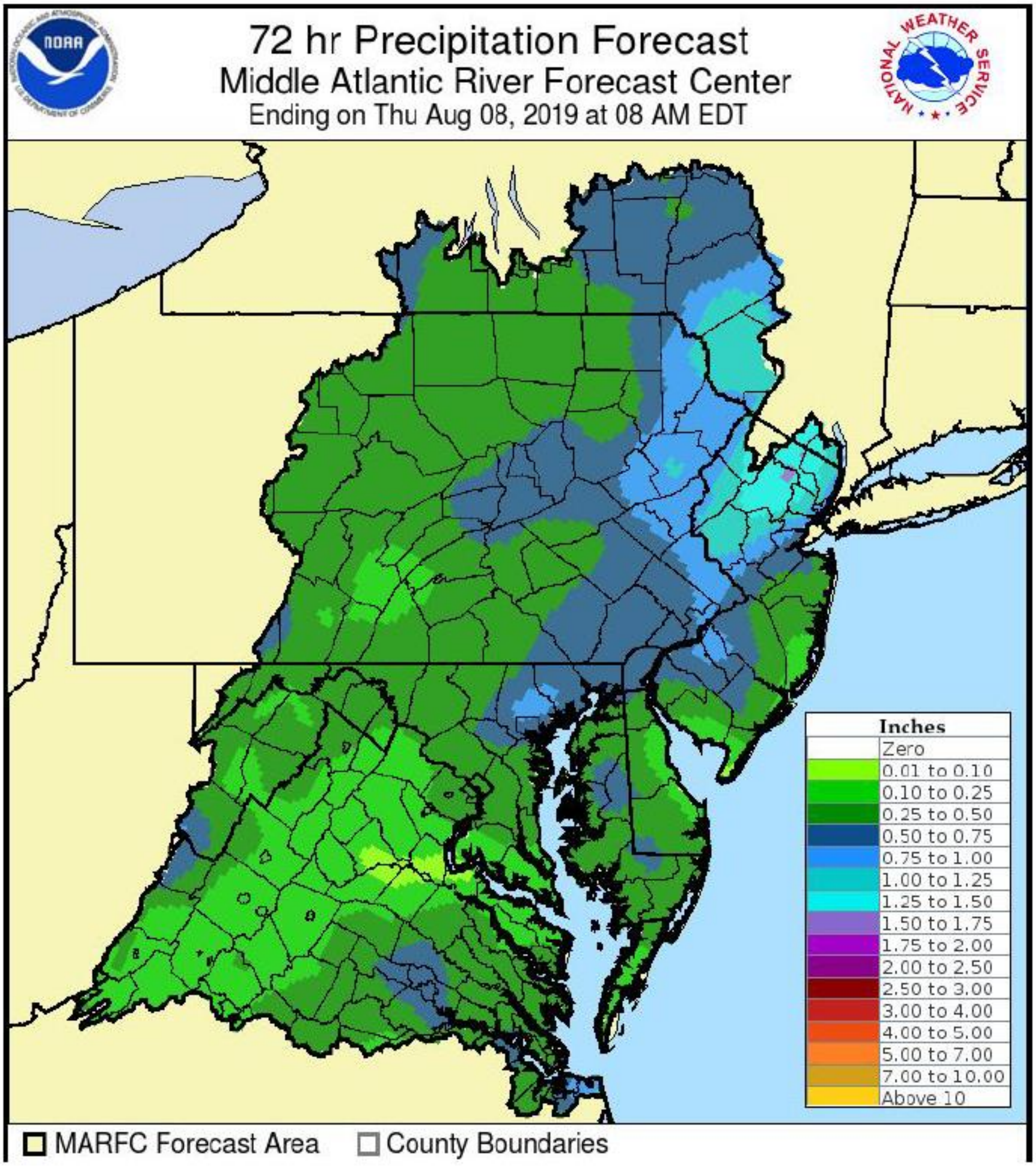
Over the past several years, MARFC has generally initialized its product with the MRMS data. Additional manual quality control by the RFC staff involves removing bad gage data, filling in areas where radar data is missing due to topography (e.g., mountains of West Virginia), and cleaning up other bad data.

MARFC precipitation gage network includes Automated Surface Observing System (ASOS), Integrated Flood Observing and Warning System (IFLOWS), HADS Satellite reporting, State Mesonets; CoCoRAHS (daily), and Cooperative Observers (daily).



MARFC's Precipitation Gage Network

MARFC includes 72-hour precipitation forecasts in their river forecasts. Forecasts are in 6-hour timesteps and are updated 3 times a day. The forecast begins with either [Weather Prediction Center](#) (WPC) or [National Blend of Models](#) (NBM) data. The forecast is modified by MARFC forecaster during the first 24 hours.



August 8, 2019 MARFC's 72-hour Precipitation Forecast

The precipitation data is in the XMRG format and covers about 16 km^2 grids. The data are only available online. The River Forecast Centers (RFC) have access to hourly data archives.

Marian Baker, NWS mentioned that the precipitation processing outlined for MARFC is similar for those of the other 12 RFCs, but each RFC has unique river basin meteorological conditions and topography that affects the QA/Q processing of precipitation data.

Tom next introduced Professor **Ramesh Teegavarapu, Hydrosystems Research Laboratory, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University** who spoke on ***Quality Assessment (QA) of Point and Gridded Precipitation Data***. Ramesh focused on issues with observations or estimations of (1) point data that are precipitation data measured at rain gauges and (2) gridded data that includes radar and satellite data products, spatially interpolated precipitation data products from either rain gauge data or radar and satellite sources, and multi-sensor data products. He outlined these QA issues: outliers and anomalies related to instrumentation, gauge placement, and related to transcription or telemetry. He discussed missing gaps in the data due to systematic and random errors and instrument malfunctions. He categorized data analysis issues using the following table.

Form	Example	Meaning	Issues with the Data
Value	11.5	Reliable	No problems were found in the automatic quality control. The value was computed from a complete dataset.
Value)	11.5)	Quasi-Reliable	Only slight problems were found in the automatic quality control, or the value was computed from the dataset with a few missing data.
Value]	11.5]	Incomplete	The value was computed from a dataset with excessive missing data.
-	-	No phenomenon	No phenomenon was observed within the period.
X	X	Missing	No value is available due to problems with observation instruments, etc.
Blank		Out of observation	No observation was conducted.
*	31*	Most recent extreme values	The value is the most recently observed of those two or more identical daily extreme values in the period.
#	#	Suspicious	A serious quality problem was found in the value, treated as omitted from the statistics.

Source: JMA, as reported by JMA

Table Categorizing Issues with the Data

Ramesh reviewed potential causes of anomalies. He listed point data issues: gaps in the data, physically impossible values, constant values, values above pre-specified thresholds, improbable zero values, unusually low values (which could be real values), and unusually high values (which could be real values). For issues with precipitation measurements, he recommended an automated approach to detect suspect data and to identify any data errors due to outliers and anomalies. Other issues were time shifts where the recorded data shifted in either direction, missing data, and values greater than pre-specified values defined by historical data.

An important QA/QC issue is evaluation and detailed examination of rainfall timeseries using graphical plotting to help identify missing gaps, minimum, maximum, overlapping period-of-record, and threshold amounts to ensure no operational problems exist. He recommended the use of boxplots for outlier identification. He discussed different methodologies for timeseries analysis: univariate timeseries approach and neighborhood multi-site approach using both multiple rain gauges in the vicinity and radar data.

Ramesh outlined in detail anomaly and outlier identification methods. He also reviewed missing data estimation procedures. His observations and conclusions were:

- To develop a data quality evaluation system, you need to consider (1) internal consistency at a site of interest including boundary consistency and (2) spatial consistency based on "***Neighborhood***" stations.

- All the outlier and anomaly detection methods for precipitation can be used at different temporal scales.

- Comprehensive assessment of historical data is critical to develop "***Rule-Based***" methods.

In his presentation slides, Ramesh provided a list of methods and references for the QA/QC assessment and statistical approaches he discussed for point precipitation data.

For ***gridded precipitation products***, Ramesh next discussed the ***radar-based analysis and estimation approaches***. He mentioned development of approaches for infilling missing rain-gauge data using radar-based precipitation estimates and gridded data generation. He stressed the need to assess how good the estimates are and how can the radar-based data be improved. He outlined his requirements for this assessment:

- To assess radar data, error-free, chronological, quality assured and quality controlled, rain gauge data are required.

- Reasonable rain gauge density to facilitate assessment.

- Rain gauge data that is spatially uniform over the radar coverage area.

- Rain gauge data are available at the same temporal resolution as the radar-based data.

These assessments involve visual, numeric and statistical approaches. Ramesh raised the following questions to assess the radar-based rainfall data:

What is the overall quality of the radar data compared to rain gage data (i.e., ground truth)?

- Are the radar and rainfall data characteristics statistically similar?

- What is the overall bias?

- What is the error structure and how it is varying in space and time?

- What is the variability of the bias in space and time?

- What is the skill of the method used for radar-based rainfall estimation in the definition of rain or no rain events?

- Do the radar-based rainfall estimates preserve the site (at a rain gage location) and regional (a set of rain gages) statistics?

- Are the rainfall fields generated by radar-based estimates and rain gauge-based observations similar?

- Can a specific index or a set of indices help provide directions to improve the radar-based rainfall data?

- How do radar and rain gage data quantitatively compare at different temporal resolutions?

- Is radar data quality appropriate for distributed hydrologic modeling?

Ramesh then provided a framework of approaches and measures to address those questions. One approach, a comprehensive bias framework, includes many measures and methods to assess bias. The bias evaluation categories include temporal, spatial, event and point. The assessment of data focused on a variety of measures, indices, and evaluation tests and methods outlined in his presentation tables. He provided a list of critical assumptions in making radar-based precipitation estimates:

- Radar-based precipitation estimates are adjusted based on rain gage observations.

- Radar-based precipitation estimates are not adjusted for each pixel (or spatial grid) in which rain gage is located or the adjustments are not based on one single rain gage.

- Bias correction procedures are generally applied to post-correction of radar-estimated data based on a specific Z-R (reflectivity-rainfall rate) relationship and by using rain gage data from a spatial network of gages.

- Observed precipitation data available from rain gages are not completely error free. However, the data available from the rain gages are assumed to be ground truth and error free without any systematic errors.

- The rain gage data should be critically evaluated before it can be used for bias analysis.

- It is expected that radar-based observations improve over time starting from near real-time to end of the day and to finally end of the month. This is mainly due to improved rain gage data quality available from the time of collection to the point in time when these data are available are adjustment of radar data.

- Non-parametric statistical tests are valid if only if the samples from the two data sets are independent. As radar data are adjusted based on rain gage data, the assumption of independence is not valid to carry out these tests.

- Radar-based rainfall estimates are considered as “model estimates” or “forecasts” as these estimates are surrogate measurements of observed rainfall amounts. This assumption also helps in the application of forecast verification indices for evaluation of radar-based data.

Ramesh pointed out that comparison of point (i.e., rain gage) and grid-based (i.e., radar) measurements are the only way to assess radar data when gridded precipitation data based on rain gage observations are not available at a specific temporal or spatial resolution. Again, he provides lists of visual, quantitative, and statistical analyses using indices, measures, metrics, scores, and tests for the comparison of datasets. He provided numerical and statistical examples from his assessment study of radar and rain gauge data. He demonstrated using performance measures the bias of 4-year rain gauge and radar data.

Ramesh's main conclusions and summary of the bias data analysis study were:

- The radar data is in good agreement with rain gage data at different temporal scales (i.e., 15-minute, hour, day, month and year).

- Scalar performance measures and skill scores calculated based on near real-time (NRT), end of the day (EOD) and end of the month (EOM) radar data sets, and CR10 rain gage data indicate good agreement of radar data with rain gage data.

- As expected, the performance of radar data sets based on all indices and skill scores progressively improved as the temporal scale of radar data adjustment for analysis is changed from near real-time to the end of the day to the end of the month. The improvement is marginal when moving from near real-time to end of the day.

- The skill scores based on radar data compared with rain gage data also improved over different years and best performance often seen in the most recent water year.

- Visual and statistical tests also suggest that radar data at all levels (near real-time, end of the day and end of the month) are in good agreement with ground truth (i.e., rain gage data).

- In general, the errors computed based on radar and rain gage data show no evidence of temporal dependence, major heteroskedasticity issues, non-normality of errors (residuals), and statistically significant autocorrelation at different lags.

- Replacements tests indicate that radar data can used for augmenting rain gage data or infilling missing data in different modes: (1) systematic, (2) random, and (3) systematic and random replacement. Homogeneity tests need to be used to confirm that rain gage data is homogeneous after infilling.

- Spatial evaluation of bias indicates significant and consistent underestimation of precipitation by radar data in two areas of the SFWMD region. These areas are generally located in the North and Southeast corners of the SFWMD region.

- Parametric and non-parametric tests used for evaluating the similarity of distributions characterizing radar and rain gage data sets provided mixed results. The two-sample Kolmogorov-Smirnov (KS), Ansari-Bradley and Wilcoxon Sum tests indicate that alternate hypothesis being true for observations at several sites.

- Transition probabilities P10 (probability of transition from wet to dry) and P11 (probability of transition from wet to wet) are underestimated and overestimated by radar data when compared to rain gage data for the temporal scale of comparison of 15 minutes. However, a different picture of probabilities evolves when the temporal scale is increased from 15 minutes to an hour or a day.

- Serial autocorrelation of rain gage and radar data are evaluated at different lags. Radar data seem to overestimate the autocorrelation at first two to three lags.

- Accumulated radar and rain gage data plots show no significant deviation of radar from rain gage data for all the gages in all the water years.

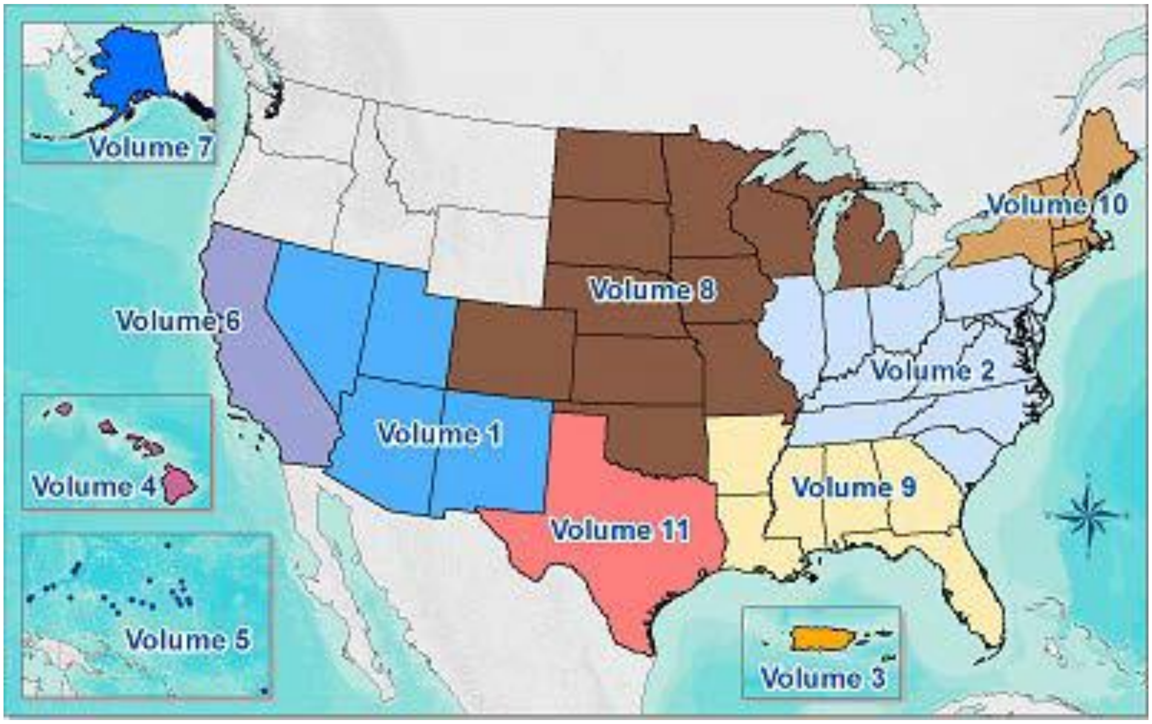
Tom introduced the final presenters **Carl Trypaluk and Michael St. Laurent, Hydrometeorological Design Studies Center (HDSC), Office of Water Prediction, NWS. NOAA**, who provided an ***Overview of Experience and Knowledge Gained Through Quality Control (QC) of Extreme Precipitation Data Used in NOAA Atlas 14.***

Their presentation covered the following issues:

- Co-located stations.
- Missing extreme rainfall events.
- Pre-1948 hourly data.
- Q flags in hourly precipitation (DSI-3240).
- WeatherCoder 3.
- Metadata QA/QC.
- Gridded products (Daymet & PRISM).

Carl Trypaluk discussed in detail the issue of co-located stations where the data from both standard and automated gauges exist at the same location, such as GHCN-daily and DSI-3240, and other data archives. He stated that it is important to ensure the period of record and data consistency. He demonstrated their QC analysis using precipitation records from Langtry, TX; Benavides, TX; Lake Colorado City, TX; and Wimberly, TX.

While working on Volume 11 of NOAA Atlas 14, they discovered that 3 of the top 5 largest daily rainfall events were missing in the pre-1941 data archive for Texas, namely 24 + inches for Hearne, TX on June 28, 1899; 23.11 inches for Taylor, TX on September 9-10, 1921; and 18 inches for Brackettville (also known as Fort Clark) on June 15, 1899. The potential causes for the missing extremes were human errors, data may exist but are not in digital archive; and gauge malfunction or overflow.



Map of the U.S. showing geographic regions covered by the NOAA Atlas 14 Volumes. Volume 11 for Texas was revised and issued in 2018 as version 2.

Carl showed examples of identifying the extreme rainfall events using paper records for Liberty, TX and Bonham, TX. He also showed examples of correcting and extending the daily precipitation data for Houston's Hobby Airport; Big Spring, TX; Austin's Bergstrom Airport; and Medina, TX daily rainfall data.

Michael St. Laurent discussed the use of pre-1948 hourly data to extend extreme rainfall data at various locations. An important source of hourly precipitation data was from scanned weather observation records obtained from the Hydrological Bulletin. Also, paper record forms created by the Works Project Administration (WPA) became available for many NOAA Atlas 14 locations in the U.S. Northeast. The WPA forms were available for many first-order stations with some records going back to 1989-1941. Two examples where DSI-3240 hourly records went back to approximately 1900 were for Philadelphia, PA and Asheville, NC. Michael presented timeseries charts of annual maximum precipitation for Philadelphia International Airport; Galveston, Tx; and Abilene Regional Airport, which were extended using the archived data.

Michael then discussed Q flags for DSI-3240 hourly data where pre-1996 usage failed an extreme value test. The tests examined if the data appeared reasonable when compared to statewide data. Q flags were also discussed for COOP data, which often needed to be verified if it appeared unusually high when compared to other local data. He noted Q-flagged values were only available via FTP and not from the NCEI CDO.

Another QC issue involved WeatherCoder 3 data during the transition from mailed paper forms to electronic records. These new problems with observations were noted by empty/missing data instead of 0s, typographical error, and multi-day precipitation not recorded properly.

Michael discussed Metadata checks where the data may be erroneously attributed to a different location than the NOAA Atlas 14 locations. Detailed checks discussed these errors.

Michael's analysis group, HDSC, looked to gridded data products to aid in their QA/QC process, particularly for more recent gauge data. He mentioned the use of the Daymet and PRISM reanalysis products and suggestions on their improvement.

In summary, significant value exists in digitizing the precipitation records, particularly for pre-1948 hourly data, and from historical storm reports to identify missing extremes. The development and archiving of complete digital datasets are critical for future updates of NOAA Atlas 14.

The meeting concluded with compliments from the ESEWG Chair to the meeting host Michael St. Laurent and his NOAA/NWS/HDSC colleagues and the six presenters: Brian Nelson, NCEI; Robert Shedd, Middle Atlantic River Forecast Center; and Marina Baker, NWS-Kansas City; Ramesh Teegavarapu, Hydrosystems Research Laboratory, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University; and Carl Trypaluk and Michael St. Laurent, Hydrometeorological Design Studies Center (HDSC), Office of Water Prediction, NWS. NOAA. The Chair plans to draft and circulate the meeting minutes with the presenters for their editing prior to posting them and the presentation slides on the ACWI/SOH/ESEWG Web site. The Chair will canvas the ESEWG members to establish the next meeting topic, date, time and venue.

Attachment 1

Meeting Agenda of the
Extreme Storm Events Work Group (ESEWG) of the
Federal Subcommittee on Hydrology (SOH)

Tuesday, August 20, 2019, 2:30 p.m. EDST
National Weather Service (NWS)/NOAA Offices
SSMC Building 2, Conference Room 8246
1325 East West Highway
Silver Spring, MD 20910

Host: Michael St. Laurent, Hydrometeorological Design Studies Center (HDSC)
Office of Water Prediction (OWP), NWS, NOAA
1325 East-West Highway, Silver Spring, MD 20910
Phone: 301-427-9545 / e-mail: Michael.StLaurent@noaa.gov

***Invitees*:** Brian Nelson, NOAA/NCEI; William Otero, USACE; ESEWG Vice-Chair; Chandra Pathak, USACE; Mary Mullusky, NWS/NOAA; Claudia Hoeft, NRCS/USDA; Mark Perry, State of Colorado; Mark Glaudemans, Director, Geo-Intelligence Division, OWP, NWS, NOAA; Victor Hom, NWS/NOAA; Marian Baker, NWS/NOAA; Gwen Chen, NOAA; Curt Jawdy, TVA; Claudia Hoeft, NRCS; Kenneth Fearon, FERC; John Onderdonk, FERC; Will Thomas, Michael Baker Associates; John England, USACE; Elena Yegorova, RES/USNRC; Siamak Esfandiary, FEMA/DHS; Sujay Kumar, NASA Goddard; Robert Mason, USGS; Kevin Quinlan, NRO/USNRC; William H. Asquith, Research Hydrologist, U.S. Geological Survey; Charles D. McWilliams, USACE; George W. Hayes, USACE; Jason Giovannettone, Dewberry Co.; Matthew Young, DOI/BIA; Ramesh Teegavarapu, Florida Atlantic University; Ken Kunkel, NCSU and NCEI; Shih-Chieh Kao, ORN, Robert Shedd, Mid-Atlantic River Forecast Center; Jason White, NRO/USNRC; Carl Tryplauk, NOAA/NWS/HDSC; Tye Parzybok, MetStat Inc.

1. Introductions and review agenda ………………… Tom Nicholson, ESEWG Chair

2. *Brief Synopsis of Select Precipitation Data Sets and Their Level of QC*

   - Hourly Precipitation Data (HPD)
     ftp://ftp.ncdc.noaa.gov/pub/data/hpd/readme.txt

   - Hydrometeorological Automated Data System (HADS)
     https://hads.ncep.noaa.gov/

   - Global Historical Climatology Network (GHCN-daily)
     https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/global-historical-climatology-network-ghcn

   - Integrated Surface Database (Global-hourly)
     https://www.ncdc.noaa.gov/isd

   - U.S. Climate Reference Network
     https://www.ncdc.noaa.gov/crn/

   - NWS Stage IV gridded precipitation
     https://www.emc.ncep.noaa.gov/mmb/ylin/pcpanl/stage4/

- Multi-Radar Multi-Sensor System (gridded precipitation) https://www.nssl.noaa.gov/projects/mrms/…………………. **Brian Nelson, NOAA/NCEI**

3. *An Example of a River Forecast Center's Precipitation Processing Procedures*………. **Robert Shedd, Service Coordination Hydrologist, NWS/Middle Atlantic River Forecast Center and Marian Baker, NWS Central Region**

4. *Quality Assessment of Point and Gridded Precipitation Datasets: Issues and Methods* …… **Ramesh S. V. Teegavarapu, Florida Atlantic University**

5. *Overview of Experience and Knowledge Gained Through Quality Control of Rain Gauge Extreme Precipitation Data Used in* ***NOAA Atlas 14*** …………. **Michael St Laurent and Carl Tryplauk, NOAA/NWS/HDSC**

6. Questions on QA/QC Issues for Precipitation Datasets and Gridded Precipitation Products ………………………… Tom Nicholson, Marian Baker, NOAA/NWS and all

7. Discuss Date, Time and Topic for the Next ESEWG Meeting ……… all

8. Adjourn

To participate remotely (Requires Firefox or Chrome Browser) please:

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PIN: 765 227#

In-person attendees need to arrive no later than @2:00 p.m. at the visitors' entrance in the NWS's SSMC Building 2 at 1325 East West Highway, Silver Spring, MD for escorting to Conference Room 8246.